

Implant Strategies During Feeding: Impact on Carcass Grades and Consumer Acceptability

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SUMMARY

Anabolic growth promotants influence beef grade factors and Warner-Bratzler shear force of steaks. This study determined beef carcass grades and consumer acceptability for cooked beef from non-implanted (control) cattle and from cattle (n=448) managed under eight different implant strategies (on feed implant/implant at 59 d=No Implant/No Implant [CON], Encore-Component T-S/No Implant [EC-N], Ralgro/Synovex Plus [R-SP], Ralgro/Revalor-S [R-RS], Revalor-S/Revalor-S [RS-RS], Revalor-S/No Implant [RS-N], No Implant/Synovex Plus [N-SP], and Synovex Plus/No Implant [SP-N]). Carcass quality and yield grade (n=403), Warner-Bratzler shear force (n=298) data and consumer taste panel evaluations (n=160) were collected. Control carcasses had smaller ($P<.05$) longissimus muscle areas than carcasses in all treatment groups except those receiving EC-N, R-SP or RS-N. Control carcasses had higher ($P<.05$) marbling scores than carcasses in all treatment groups except those receiving R-RS or EC-N. Steaks from control steers had lower ($P<.05$) Warner-Bratzler shear force values than steaks from steers given RS-N. Consumer ratings for tenderness like and tenderness level were influenced ($P<.05$) by implant strategy. Effects of implant strategy on overall like, flavor like and flavor intensity approached significance ($P=.07-.09$). Consumers rated steaks from non-implanted steers as more tender (tenderness level; $P<.05$) than steaks from all treatment groups except that involving ECN. Although use of implants in this study resulted in heavier hot carcass weights and larger ribeyes, some of the implant strategies reduced consumer preference of tenderness of steaks.

Key Words: Beef, Implants, Carcass Traits, Eating Quality

INTRODUCTION

The U.S. beef cattle industry has adopted the use of growth promoting implants as a routine management practice because of market incentives to increase growth rates and reduce costs of live weight gain.

Morgan (1997) and Belk and Cross (1988) concluded that use of anabolic growth promotants can compromise beef carcass quality grades due to reduced marbling scores and increased incidence of dark cutters. More importantly, some implanting strategies have reduced eating satisfaction of the subsequent beef product, specifically by increasing the incidence of tough beef as determined by Warner-Bratzler shear force (Morgan, 1997; Foutz et al., 1997). This study evaluated the impact of seven implant strategies, compared to a non-implanted control, on beef carcass quality and yield grade characteristics and consumer acceptability of cooked beef from small/medium framed, British crossbred steers.

MATERIALS AND METHODS

Cattle Background. Small to medium framed steers (n = 448) from a three breed (Red Angus, Hereford, and Shorthorn) cross were used for the study. Calves were not implanted before being placed on the diet. Upon placement in the feedyard, and at the time of processing; steers were allocated randomly to one of 64 feeding pens and implant strategy (control or treatment) was randomly allocated to eight pens of steers.

Implant strategies were as follows: 1 (CON) = No Implant/No Implant; 2 (EC-N) = Encore & Component T-S/No Implant; 3 (R-SP) = Ralgro/Synovex Plus; 4 (R-RS) = Ralgro/Revalor-S; 5 (RS-RS) = Revalor -S/Revalor-S; 6 (RS-N) = Revalor-S/No Implant; 7 (N-SP) = No Implant/Synovex Plus; 8 (SP-N) = Synovex Plus/No Implant.

Implant Protocol. Implants were administered to cattle in the seven treatment groups at 0 d on feed (if appropriate for that treatment) followed by another implant at 59 d on feed (if appropriate for that treatment) in mid-April. The steers were fed 140 or 141 days and harvested in two equally balanced groups.

Carcass Evaluation.

Following a 36-hr carcass chilling period, Colorado State University personnel obtained carcass grade data. Data for fat thickness, adjusted fat thickness, longissimus muscle area, percent kidney, pelvic and heart fat, lean maturity, skeletal maturity, overall carcass maturity and marbling score were obtained for each carcass. Yield grades were calculated using regression equations and quality grades were determined after evaluation by combining the overall maturity and the marbling scores.

Strip Loin Selection and

Collection. The carcasses were fabricated and designated strip loins (NAMP #180) were collected and shipped to Colorado State University (CSU) where steaks were cut for Warner-Bratzler shear force at CSU and consumer sensory panel evaluation at CSU and Texas A&M University.

Warner-Bratzler shear force. Each strip loin (n = 298) was aged for 14 days under refrigerated conditions (5°C). Following aging, strip loins were cut into 1 in thick steaks for Warner-Bratzler shear force analysis and for consumer sensory panel analysis. Each steak was turned at 4, 8, 12, and, if necessary, 16 minutes until reaching an internal steak temperature of 160°F. At the designated internal temperature, each steak was removed from the broiler, cooled to room temperature (approximately 68°F) and six to ten .5 in cores were removed from each steak parallel to the muscle fiber orientation using a mechanical coring device.

Consumer Panelist Selection. A telemarketing firm (Client Insight, Fort Collins, CO) with expertise in conducting telephone surveys and consumer recruitment recruited consumers in College Station, Texas (n = 150) and Fort Collins, Colorado (n = 150) using randomly generated telephone listings. Each steak sample for a given session was evaluated by a minimum of four and a maximum of six consumers.

Sample Preparation. Twenty steaks per control or treatment group were selected randomly using a random number generator for sensory evaluation. Steaks from each selected strip loin were evaluated by consumers in both Texas and in Colorado.

Steaks were cooked on an open-hearth Farberware grill (Model R4550, Farberware Products, Nashville, TN). Steaks were cooked to an internal temperature of 80°F, at which time they were turned and cooked to a final internal temperature of 160°F. Steaks were cut into approximately .25 in X .25 in X .5 in cubes, covered, and placed in a warming oven (120°F) until served to consumers. Sessions lasted approximately 60 min.

Consumer Sensory Evaluation. Consumers were seated in a random, circular order in a room containing standard fluorescent lighting. Consumers then were asked to answer 11 demographic and meat consumption questions that appeared on the ballot. Each consumer evaluated one steak sample from each of the eight control or treatment groups during each session.

Consumers rated each sample for overall like/dislike, flavor like/dislike, intensity of flavor, tenderness like/dislike, level of tenderness and level of juiciness using 9-point, end-anchored hedonic or intensity scales where: 1 = like extremely, like extremely, none or extremely bland, like extremely, extremely tender, and extremely juicy, respectively; and 9 = dislike extremely, dislike extremely,

extremely intense, dislike extremely, extremely tough and extremely dry, respectively.

Statistical Analysis. For carcass traits and Warner-Bratzler shear force values, individual steers/carcasses were considered to be the experimental unit. The mixed model analysis included treatment as a fixed effect and pen within treatment as a random block effect. The pen within treatment random effect only was significant for hot carcass weight, adjusted fat thickness, longissimus muscle area, percent kidney, pelvic, and heart fat and skeletal maturity. Because pen within treatment effects (random block effects) were not significant for the other dependent variables, the General Linear Models procedure of SAS (1996) was used to evaluate those response variables using treatment as a fixed effect. Analysis of variance (AOV) was used to ascertain if responses differed by control or treatment group. When treatment effects were significant ($P < .05$), least squares means were reported and separated using a pairwise t-test procedure of SAS (1996). The distributions of quality and yield grades, as well as the Warner-Bratzler shear force (WBS) values were compared using the chi-square option of the frequency procedure of SAS (1996). If the overall chi-square value was significant, Fisher's Exact Test (SAS, 1996) was used to separate the percentages of USDA Prime plus USDA Choice, USDA Yield Grade 1 plus USDA Yield Grade 2 and the percentage of WBS values over 8.5 lb.

Consumer sensory panel data were analyzed using the Mixed Models procedures of SAS (1996). Analysis of variance (AOV) was used to ascertain if responses differed by control or treatment group. Treatment was included in the model as a fixed effect and panelist within city by session was included as a random effect. When treatment effects were significant ($P < .05$), least squares means were reported and separated using the pairwise t-test procedure of

SAS (1996). Simple regression coefficients were calculated, based on sample means calculated from the 6 panelist evaluations in each city, using correlation procedures of SAS (1996).

RESULTS AND DISCUSSION

Carcass Evaluation and Warner-Bratzler Shear force. Ears of all cattle were palpated at re-implant and at harvest by licensed veterinarians. Frequency of implant defects ranged from 2 (in the R-SP treatment group) to 10 (in the EC-N treatment group). Overall, 37 of the original 448 steers (8.3%) were removed due to improper implant application or implant damage before further selection or analysis was conducted.

The pen within treatment effect was significant for hot carcass weight, adjusted fat thickness, longissimus muscle area and skeletal maturity ($P < .05$). Using the appropriate AOV model, least squares means for beef carcass quality and yield factors are presented in Table 1. All groups receiving implant(s), except for the EC-N treatment, had higher ($P < .05$) hot carcass weights than did the non-implanted cattle. Control carcasses had smaller longissimus muscle areas ($P < .05$) than carcasses from cattle in all treatment groups except those in the EC-N, R-SP, and RS-N groups. Steers in the RS-RS, R-RS, N-SP Plus and SP-N treatment groups had carcasses with significantly larger ribeyes than steer carcasses from the control group.

There was no difference ($P > .05$) in adjusted fat thickness among carcasses from the eight implant strategy groups. Carcasses from steers in all treatments, except those involving EC-N and SP-N, had lower percentages ($P < .05$) of kidney, pelvic, and heart fat than carcasses from steers in the negative control group.

While differences occurred among carcasses in treatment groups in several of the factors used to compute USDA yield grades, only one significant difference in final yield grade was observed. Given the impact

of implants on hot carcass weight, longissimus muscle area and percentage kidney, pelvic and heart fat, the resulting yield grades were not ultimately effected as the increase in yield grade due to hot carcass weight and kidney, pelvic and heart fat and the reduction in the yield grade as a result of increased longissimus muscle area offset one another in the computations. Carcasses from steers treated with N-SP Plus had a more desirable mean yield grade than carcasses from steers treated with RS-N.

Except for carcasses from steers treated with N-SP Plus, skeletal maturity scores for implanted steer carcasses were more advanced ($P < .05$) than for those from the non-implanted steer carcasses. In this study, while carcasses in treatment subclasses differed in skeletal maturity, there were no differences among treatments in lean maturity scores of carcasses.

Except for carcasses from steers treated with R-RS or EC-N, control carcasses had higher ($P < .05$) marbling scores than carcasses from steers treated with implants. Except for carcasses from steers receiving R-RS or EC-N, control carcasses had higher ($P < .05$) USDA quality grades than carcasses from implant-treated steers. The percentage of carcasses grading Prime or Choice ranged from 94.4% for control steers to 66.7% for steers from the RS-RS treatment (Table 2). Except for carcasses from steers implanted with EC-N or R-RS, control steers produced higher ($P < .05$) percentages of Prime plus Choice carcasses than did treated steers.

The percentage of carcasses grading Yield Grade 1 or 2 ranged from 18.5% for control steers to 3.9% for steers from the RS-N treatment (Table 2). The numerical percentages of carcasses that were Yield Grade 1 or 2 did not differ ($P > .05$) among the eight implant strategy groups.

Warner-Bratzler shear force was determined for 298 samples due to the loss of 22 strip loins during fabrication in the packing plant. Steaks from carcasses of steers implanted with RS-N were tougher ($P < .05$) than steaks from carcasses from control (non-implanted) steers (Table 5); besides the RS-N treatment, no other treatment WBS force value differed ($P > .05$) from that of the control group.

Shackelford et al. (1991) identified a shear force value of 8.5 lb as a threshold value for consumer desirability of steaks. Of the loin steaks from carcasses of steers receiving implants (Table 4), those from the RS-N treatment group were most often "tough" (30.6% had a shear force value > 8.5 lb). Steaks from non-implanted steers were least often "tough" (8.3% had a shear force value > 8.5 lb) but none of these percentages differed statistically ($P > .05$).

Consumer sensory panels.

Consumer age was slightly skewed to the younger categories; however, evaluations were collected for consumers in every age category. Of the incomes reported, the highest percentage of consumers had a yearly income of $< \$20,000$, most likely because 17.1% of the consumers defined themselves as students. Distributions were similar among the remaining income categories for consumer incomes that were recorded. A very high percentage of consumers were white. The ethnic background distribution was not necessarily representative of the ethnic background of each of the communities in which panels were conducted, but most likely reflected willingness to participate.

Consumer ratings for tenderness like/dislike, tenderness level, cooking time and cooking weight loss were influenced ($P < .05$) by implant strategy. Steaks from cattle in the control group had a higher ($P < .05$) percentage of cooked steak weight loss than steaks from cattle treated

with RS-RS. Cooking time to the 160°F endpoint for steaks from non-implanted steers was shorter ($P < .05$) than for steaks in the R-RS group.

Consumers rated steaks from non-implanted steers as more tender ($P < .05$) than steaks from six treatment groups; not, though, than steaks from steers treated with EC-N (Table 3). Steaks from the EC-N treatment group were similar in tenderness to steaks from the other treatments ($P > .05$) and tended to be rated tougher than steaks from non-implanted steers ($P = .0552$). Consumers rated steaks from non-implanted steers as more desirable ($P < .05$) for tenderness like/dislike than steaks from five treatment groups (not, though, than steaks from steers treated with EC-N and RS-N). Based on these results, use of R-SP, R-RS, RS-RS, N-SP Plus and SP-N treatment strategies for finishing steers results in decreased tenderness desirability (like/dislike) and tenderness rankings (level) in a population of loin steaks derived from small to medium-framed cattle that were fed to an excessively high degree of finish.

Comparisons of sensory panel evaluations across implant strategy groups revealed that differences in overall like/dislike ($P = .0935$), flavor like/dislike ($P = .0832$) and flavor intensity ($P = .0729$) approached statistical significance.

IMPLICATIONS

The Beef Industry Long Range Task Force of the National Cattlemen's Beef Association documented "the opportunity to increase tenderness both pre- and post-harvest and through preparation" as one of the demand drivers for the beef industry. The fact that growth promotants increase the production efficiency of cattle is widely known. Based on the results of this study, growth promotants may be detrimental to the tenderness of the product. Producers must determine the potential impact of implants when used within their genetic base. The

beef industry must determine the interaction of the impact of growth promotants on beef acceptability and the ability to increase tenderness using pre-harvest practices.

LITERATURE CITED

- Belk, K. E., and H. R. Cross. 1988. Effects of trenbolone acetate, estrogens on steers explored. In: *Feedstuffs*. 61(50):15. Miller Publishing Company, Minnetonka, MN.
- Foutz, C. P., H. G. Dolezal, T. L. Gardner, D. R. Gill, J. L. Hensley, and J. B. Morgan. 1997. Anabolic implant effects on steer performance, carcass traits, subprimal yields, and longissimus muscle properties. *J. Anim. Sci.* 75:1256-1265.
- Morgan, J. B. 1997. Implant program effects on USDA beef carcass quality grade traits and meat tenderness. *Oklahoma State University Implant Symposium Proceedings*. pp 147.

Table 1. Least squares means for carcass traits stratified by implant group (n = 403)

Implant Strategy ^a (n)	HCW ^b (lb)	AFT ^c (in)	LMA ^d (in ²)	KPH ^e (%)	YG ^f	Marb ^g	Smat ^h	QG ⁱ
CON (54)	737.4 ^l	.66	12.0 ^m	2.03 ^k	3.51 ^{kl}	524.3 ^k	65.6 ^m	523.8 ^k
EC-N (44)	777.2 ^{kl}	.65	12.5 ^{klm}	1.86 ^{kl}	3.47 ^{kl}	511.6 ^{kl}	72.3 ^{kl}	515.1 ^{kl}
R-SP (53)	798.8 ^k	.69	12.6 ^{klm}	1.79 ^l	3.59 ^{kl}	459.2 ^{lm}	74.2 ^{kl}	460.7 ^m
R-RS (48)	796.8 ^k	.64	12.8 ^{kl}	1.67 ^l	3.40 ^{kl}	482.7 ^{klm}	74.4 ^{kl}	487.5 ^{klm}
RS-RS (48)	809.5 ^k	.67	13.1 ^k	1.76 ^l	3.45 ^{kl}	449.6 ^m	77.3 ^k	454.1 ^m
RS-N (52)	795.9 ^k	.71	12.4 ^{lm}	1.81 ^l	3.70 ^k	467.0 ^{lm}	75.0 ^{kl}	474.0 ^{klm}
N-SP (52)	791.0 ^k	.64	12.8 ^{kl}	1.80 ^l	3.35 ^l	458.3 ^m	69.4 ^{lm}	463.4 ^{lm}
SP-N (52)	794.1 ^k	.71	12.8 ^{kl}	1.85 ^{kl}	3.61 ^{kl}	470.4 ^{lm}	76.0 ^k	471.4 ^{lm}
SEM ^j	15.1	.03	.2	.07	.09	13.2	2.1	13.7

^a Implant Strategy: CON = No Implant/No Implant (Control), EC-N = Encore&Component T-S/No Implant, R-SP = Ralgro/Synovex Plus, R-RS = Ralgro/Revalor-S, RS-RS = Revalor-S/Revalor-S, RS-N = Revalor-S/No Implant, N-SP = No Implant/Synovex Plus, SP-N = Synovex Plus/No Implant.

^b HCW: Hot Carcass Weight.

^c AFT: Adjusted Fat Thickness.

^d LMA: Longissimus muscle area.

^e KPH: Kidney, Pelvic and Heart Fat.

^f YG: Yield Grade, calculated using regression equations.

^g Marbling scores are coded as: 300 = Slight, 400 = Small, 500 = Modest, and 600 = Moderate.

^h Skeletal maturity scores are coded as: 1 to 100 = A maturity; 77.3 is A⁷⁷, et cetera.

ⁱ USDA quality grades are coded as: 100 to 299 = Standard, 300 to 349 = Low Select, 350 to 399 = High Select, 400 to 499 = Low Choice, 500 to 599 = Average Choice, and 600 to 699 = High Choice.

^j SEM: Standard Error of the Mean (overall mean) for the given trait.

^{k,l,m} Means, in the same column, bearing a common superscript letter are not different (P > .05).

Table 2. Distribution of Quality Grades by Implant Strategy

Implant Strategy ^a	% Prime/Choice	% Y1/Y2 ^b
CON	94.4 ^c	18.5 ^c
EC-N	93.2 ^{cd}	15.9 ^c
R-SP	77.4 ^e	9.4 ^c
R-RS	81.3 ^{cde}	16.7 ^c
RS-RS	66.7 ^e	12.5 ^c
RS-N	76.9 ^e	3.9 ^c
N-SP	78.9 ^{de}	19.6 ^c
SP-N	75.0 ^e	13.7 ^c

^a Implant Strategy: CON = No Implant/No Implant (Control), EC-N = Encore&Component T-S/No Implant, R-SP = Ralgro/Synovex Plus, R-RS = Ralgro/Revalor-S, RS-RS = Revalor-S/Revalor-S, RS-N = Revalor-S/No Implant, N-SP = No Implant/Synovex Plus, SP-N = Synovex Plus/No Implant.

^b % Yield Grade 1/Yield Grade 2.

^{c,d,e} Means, in the same row and for the same trait, bearing a common superscript letter are not different (P > .05).

Table 3. Least Squares Means for Consumer Sensory Responses by Implant Strategy

Implant Strategy ^a (n)	Overall L/D ^b	Flavor L/D ^c	Flavor Intensity ^d	Tenderness L/D ^e	Tenderness Level ^f	Juiciness Level ^g
CON (54)	4.25	4.14	5.23	3.94 ^l	3.90 ^l	4.87
EC-N (44)	4.47	4.34	4.97	4.25 ^{ij}	4.25 ^{ij}	5.06
R-SP (53)	4.61	4.47	4.95	4.48 ⁱ	4.50 ⁱ	5.01
R-RS (48)	4.71	4.52	4.83	4.42 ⁱ	4.49 ⁱ	5.27
RS-RS (48)	4.61	4.34	5.10	4.54 ⁱ	4.53 ⁱ	5.26
RS-N (52)	4.42	4.33	5.20	4.27 ^{ij}	4.45 ⁱ	4.94
N-SP (52)	4.69	4.71	4.80	4.48 ⁱ	4.48 ⁱ	5.28
SP-N (52)	4.73	4.47	5.14	4.46 ⁱ	4.54 ⁱ	5.21
SEM ^h	2.0	2.0	2.0	2.1	2.1	2.2

^a Implant Strategy: CON = No Implant/No Implant (Control), EC-N = Encore&Component T-S/No Implant, R-SP = Ralgro/Synovex Plus, R-RS = Ralgro/Revalor-S, RS-RS = Revalor-S/Revalor-S, RS-N = Revalor-S/No Implant, N-SP = No Implant/Synovex Plus, SP-N = Synovex Plus/No Implant.

^b Overall like to dislike rating by consumers where: 1 = like extremely and 9 = dislike extremely.

^c Like to dislike rating of flavor by consumers where: 1 = like extremely and 9 = dislike extremely.

^d Intensity of flavor rated by consumers where: 1 = none or extremely bland to 9 = extremely intense.

^e Like to dislike rating of tenderness by consumers where: 1 = like extremely and 9 = dislike extremely.

^f Level of tenderness rating by consumers where: 1 = extremely tender and 9 = extremely tough.

^g Level of juiciness rating by consumers where: 1 = extremely juicy and 9 = extremely dry.

^h SEM: Standard Error of the Mean for the given trait.

^{ij,k,l} Least squares means, within a row bearing a common superscript letter are not different (P > .05).

Table 4. Least Squares Means of Warner-Bratzler Shear Force values stratified by Implant Strategy (n = 298)

Implant Strategy ^a	WBS Value (lb) ± SEM	% > 8.5 lb
CON	6.54 ± 1.44 ^c	8.3
EC-N	7.01 ± 1.05 ^{bc}	7.7
R-SP	7.52 ± 1.28 ^{bc}	21.1
R-RS	7.28 ± 1.37 ^{bc}	26.3
RS-RS	7.23 ± 1.18 ^{bc}	13.9
RS-N	7.74 ± 1.33 ^b	30.6
N-SP	7.54 ± 1.48 ^{bc}	29.7
SP-N	7.25 ± 1.12 ^{bc}	16.2

^a Implant Strategy: CON = No Implant/No Implant (Control), EC-N = Encore&Component T-S/No Implant, R-SP = Ralgro/Synovex Plus, R-RS = Ralgro/Revalor-S, RS-RS = Revalor-S/Revalor-S, RS-N = Revalor-S/No Implant, N-SP = No Implant/Synovex Plus, SP-N = Synovex Plus/No Implant.

^{b,c} Means, in the same row and for the same trait, bearing a common superscript letter are not different (P > .05).